National Aeronautics and Space Administration

Office of the Administrator
Washington, DC 20546-0001

January 4, 2011

Dr. Kenneth Ford
Chairman
NASA Advisory Council
Washington, DC 20546

Dear Dr. Ford:

Enclosed are NASA's responses to the five recommendations from the NASA Advisory Council meeting held on April 28-29, 2010, at Johnson Space Center. In addition, enclosed is NASA's response to an earlier Council recommendation stemming from 2009.

Please do not hesitate to contact me if the Council would like further background on the information provided in the enclosures.

I appreciate the Council's thoughtful consideration of these issues and welcome its continued observations, recommendations, and advice concerning the U.S. civil space program. I look forward to working closely with you and the members of the Council in the future.

Sincerely,

Charles F. Bolden, Jr.
Administrator

6 Enclosures
1. 2010-02-12 (SOC-01) Ensuring International Space Station Capabilities are More Widely Known
2. 2010-02-13 (SOC-02) Operational Model for Commercial Space Vehicles
3. 2010-02-15 (TIC-02) NASA Life and Physical Sciences
4. 2010-02-17 (TIC-04) Share the Work, Share the Results
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6. 2009 (SC-09-05) Study of Space Communications – Requirements, Capabilities and Architecture

Tracking Number: 2010-02-12 (SOC-01)
Ensuring International Space Station Capabilities are More Widely Known

NASA Advisory Council Recommendation:
The Council recommends that NASA make the International Space Station (ISS) capabilities, achievements, and potential services more widely known outside the NASA community, especially within the business world. Consideration should be given to new and innovative approaches for doing so.

Major Reasons for the Recommendation:
The Space Operations Committee is very impressed with the past, current, and future capabilities of ISS. Some examples include: microbial vaccine development for staph aureus (MRSA) and salmonella, cancer treatment delivery, plant growth, macromolecular crystallization for Duchenne's muscular dystrophy, regenerative environmental systems, and education, to name a few. Research includes not only NASA and the international partners, but Department of Defense, National Institutes of Health, and commercial partners through the National Laboratory. NASA has used Space Act Agreements with various commercial organizations. While these appear to be quite successful, the committee believes there are still missed opportunities in the commercial sector, as many non-traditional partners are not aware of the capabilities and potential of ISS. The Space Operations Committee recommends that NASA look for new ways to make these capabilities known, either by marketing, appearing at non-traditional gatherings, broad announcements, or short educational articles in business publications. Some industry examples are: health care, environmental, or energy.

NASA Response:
NASA concurs and has continued to broaden outreach efforts through the generation and publication of "Research in Space – Facilities on the International Space Station" http://www.nasa.gov/pdf/393789main_iss_utilization_brochure.pdf. This publication describes all the research facilities on the ISS, as well as some research results highlights. It has been distributed to thousands of prospective users of the ISS and includes points of contact for each participating ISS Partner agency. NASA and its ISS Partner agencies are continuing with outreach efforts by recently publishing "The Era of International Space Station Utilization: Perspectives on Strategy from International Research Leaders," developed by international research leaders, including both ISS and non-ISS investigators. This publication will be posted to the Web site and distributed to prospective users of the ISS.

Since November 2009, new agreements have been established with the Defense Advanced Research Program Agency, the National Science Foundation (NSF), Boeing, Microsoft, and LEGO. Agreements are currently under development with multiple university researchers and one private firm. In the past few months, new NASA Research Announcements (NRAs) have been announced in "Crew Health and Performance and Materials Science" at

http://www.nasa.gov/mission_pages/station/science/nlab/nlab_proposal.html. The upcoming NRAs from the Science Mission Directorate for "Research Opportunities in Space and Earth Sciences" and the "Explorer 2010 Missions of Opportunity Program Element Appendix" for the "Stand Alone Missions of Opportunity Notice Announcement of Opportunity," will both list ISS as an available platform. Additionally, the National Laboratory Office has posted a Broad Agency Announcement (BAA) titled "Enabling Support Equipment and Services for International Space Station as a National Laboratory," which can be found at http://www.nasa.gov/mission_pages/station/science/nlab/index.html. The BAA is focused on commercial sector use and servicing of ISS and will be updated annually. NASA has added the capability to deploy CubeSats from the ISS commercial cargo resupply missions as another means of opening up the opportunity for space flight research to a larger group. NASA will continue to issue new NRAs, consistent with future funding availability.

Beginning in January 2010, a team was assembled to begin restructuring of the ISS Home page to include restructuring of the ISS Science pages. Improvements to the ISS Science Web pages will provide:

- Improved usability overall (i.e. clear, concise, and updated links).
- Clear ISS research mission statements, including research structure and science goals.
- New ISS research metrics page.
- Updated research news.
- Quick links for educators and students interested in ISS science.
- References and process outlines for potential and current ISS investigators, including potential funding sources and processes ("users guide").
- Improved search functions for items such as ISS facilities, experiments and results, and ISS publications.
- ISS research translations to Earth benefits in a single Web location.
- Improvements to the National Laboratory Office Web page, to include sections for potential investigators, agreements, processes, and funding information.
- Upcoming events related to ISS science.
- Current events in ISS science.

Additionally, the first ISS Research Academy for new investigators was held August 3-5, 2010. Detailed information on the ISS Research Academy can be found at http://www.nasa.gov/mission_pages/station/science/nlab/nlab_conferences.html. This three-day event detailed the science that can be done on ISS during day one, the research opportunities (both NASA and non-NASA) and how to submit them during day two, and the process for working on ISS during day three. Part of the second day was devoted to the commercial companies that can provide services to researchers to enable them to successfully work through the ISS processes. A portion of the third day was used for a feedback session from the payload developers and the experienced Principal Investigators to aid NASA in modifying processes and systems that were overly cumbersome to the users. Based on this feedback, changes to the systems that the payload developers and Principal Investigators use routinely are being evaluated for implementation in the FY 2011 timeframe. NASA is

currently evaluating the effectiveness of the forum and determining the right frequency and locations for repeating the forum.

Finally, consistent with the direction in the President's FY 2011 Budget to Congress, NASA is in the process of establishing a nonprofit organization (NPO) through a competitive process to manage the U.S. national (i.e. non-NASA) uses of the ISS. It is anticipated that this NPO will have more latitude to broadcast the capabilities and services of the ISS to a wider audience than NASA, as well as publicize the ISS accomplishments. NASA anticipates starting the cooperative agreement competition this spring 2011 and awarding the NPO agreement during the third quarter of 2011. Management of the ISS research program will be transferred during the fourth quarter of 2011.

Tracking Number: 2010-02-13 (SOC-02)
Operational Model for Commercial Space Vehicles

NASA Advisory Council Recommendation:
The Council recommends that NASA develop an operational model for commercial space vehicles that will enable NASA flight resources and crews to be committed to commercial space systems.

Major Reasons for the Recommendation:
As Space Operations Mission Directorate support of ISS operations moves from "government owned and operated" space operations, to "privately owned and leased" space operations, there will be major changes. These changes involve not only the obvious new hardware, software, documents, and procedures, but new risks, new relationships, a new business model, and a new culture. The model should address basic systems requirements, such as failure tolerance, NASA Program Management, NASA Engineering, Ground Operations, Flight Operations, Flight Crew involvement in development, certification requirements (what is required to commit NASA resources, pilots and passengers to the flight system), certification buyoff (how will NASA verify certification requirements), roles and responsibilities of NASA and the system developer, for ground operations, flight operations, and flight crew operations, and the role of company and government pilots/astronauts. The operational model should be drawn up initially for the cargo mission. An operational plan for the crew mission should follow.

NASA Response:
NASA concurs with this recommendation. The ISS Program, along with the Office of Safety and Mission Assurance, the Astronaut Office, the JSC Mission Operations Directorate, and the Launch Services Program, have developed plans and procedures for all aspects of commercial cargo transportation services from the ISS design requirements for safety and fault tolerance, to preflight planning, training, testing and simulations, ground cargo handling, ISS proximity operations and berthing, on-orbit crew handling of cargo, and planning for contingencies involving off-nominal scenarios. The ISS Program would like to offer a briefing to the NAC's Space Operations Committee to fully present all aspects of commercial cargo integration into the ISS Program, including a discussion of safety and crew interaction planning. Additionally, the Agency is working the broader topic of commercial crew transportation. The outcome from this activity will be made available to both the Space Operations Committee and the Commercial Space Committee.

Tracking Number: 2010-02-15 (TIC-02)
NASA Life and Physical Sciences

NASA Advisory Council Recommendation:
The Council recognizes the importance of life and physical sciences research in future human exploration activities and urges the Agency to engage in deliberative and inclusive discussions about how to manage it coherently across the NASA organization.

Major Reasons for the Recommendation:
The Committee wants to ensure that this topic, which extends across almost all NASA's activities, is well-coordinated.

NASA Response:
NASA concurs with the Council's recommendation pertinent to the importance of Life and Physical Sciences Research in future human exploration activities.

The President's Budget Request for FY 2011 directs NASA to implement the Life and Physical Sciences portfolio in the SOMD in order to more closely coordinate it with other U.S. research objectives being pursued in the context of ISS operation as a national laboratory. This was directed in the 2005 NASA Authorization Act and supported by recommendations of the Review of U.S. Human Spaceflight Plans Committee (Augustine Committee) in 2009. This Life and Physical Sciences portfolio was previously managed under ESMD in FY 2010. In cooperation with ESMD, SOMD has developed an implementation strategy that continues to pursue the entire research portfolio as previously planned.

Further progress in defining the future scope of research on the ISS is subject to the NASA Authorization Act of 2010 and the FY 2011 Congressional appropriations processes currently underway. Once the FY 2011 NASA Budget has been appropriated by the Congress, statutory requirements contained therein, as well as recommendations from the 2009 Congressionally directed Decadal Survey on Biological and Physical Sciences in Space being conducted by the National Research Council (NRC), will be employed to further shape the future research agenda for the ISS. NASA is pleased to share the new Congressional requirements and NRC recommendations with the Council as soon as they become available and will continue to manage the research agenda in close adherence to Federal policy.

The NRC's Committee for Decadal Survey on Biological and Physical Sciences in Space also issued an interim report in July 2010 which is available at the following links:
http://www.nap.edu/catalog.php?record_id=12944#toc
http://www.nap.edu/catalog.php?record_id=12944#toc

Tracking Number: 2010-02-17 (TIC-04)
Share the Work, Share the Results

NASA Advisory Council Recommendation:
The Council strongly urges NASA to quickly engage with other Federal Agencies and Departments as it develops its new technology programs. NASA can both benefit from and contribute to research and development in other parts of the U.S. Government.

Major Reasons for the Recommendation:
NASA can both benefit from and contribute to research and development in other parts of the Government. The benefit will redound not just to NASA and the other agencies, but to the entire country.

NASA Response:
NASA concurs with the Council's recommendation. NASA has a strong legacy of interagency partnerships that we will build on. During the past five years, NASA has had approximately 364 interagency partnerships with over 30 partners, about two thirds of which were partnerships with Department of Defense agencies. NASA's Office of the Chief Technologist (OCT) has actively engaged a number of Federal agencies and departments in planning and formulating its new Space Technology programs. To date, OCT has engaged the U.S. Defense Advanced Research Projects Agency, the Advanced Research Projects Agency – Energy, the National Science Foundation, the Intelligence Advanced Research Projects Activity, the Department of Defense's Director for Defense Research and Engineering, and the U.S. Air Force Research Laboratory. Senior, as well as working-level, discussions concerning NASA research and technology programs/plans and possible collaboration with these U.S. Government agencies are ongoing and will continue on a regular basis. Recently, NASA received Congressional approval to reallocate $36.5 million in FY 2010 funding to accelerate eight high-priority research projects. Three of these research and technology projects will be system studies conducted in collaboration with DARPA to investigate horizontal launch capabilities, in-orbit satellite servicing, and power-beam propulsion. Additionally, a key element of the OCT organization is the Partnerships, Innovation, and Commercial Space office. Building on the success of NASA's Innovative Partnership Program, this functional element has the specific responsibility of increasing NASA's collaboration with industry, academia, and other Government agencies.

NASA will also engage other U.S. Government agencies in the development of NASA technology roadmaps. This integrated set of technology-area roadmaps are under development by the OCT, with the goal of providing long-term recommendations and prioritizations for the Agency's technology investment "pathways." The approach involves using NASA's Strategic Goals, Outcomes, and Objectives, as well as the strategic plans of the NASA Mission Directorates, with substantial inputs from other Government agencies, academia, and industry,

to identify the highest-priority technology investments. NASA has engaged the NRC to develop technology inputs from academia, industry, and other Government agencies, and to conduct the formal review process of the roadmaps. The key is to ensure that these roadmaps have full involvement and vetting by the space technology partners and stakeholders both internal and external to the Government. By relying on the NRC to perform this input collaboration and review function, we provide for credibility and openness in this roadmapping process. Once established, this agency-level technology roadmap will be visited each year to assess performance and make mid-course corrections. In addition, these roadmaps will be fully revised every four years (consistent with NASA Strategic Plan updates) through a formal peer-review process. A formal release of the first complete (externally peer reviewed) version of this planning material will occur by October 1, 2011.

NASA has played, and will continue to play, a significant role in interagency efforts to transfer technology from Federal research laboratories to the private sector. NASA is one of the key agency participants in the Federal Laboratory Consortium, a national organization chartered by Congress to foster technology transfer from Federal agencies to state and local governments, academia, and the private sector.

NASA will also continue collaborative efforts with other Federal agencies and local government/economic development organizations to help make more visible the technologies emerging from Federal laboratories that may benefit the private sector. Recent technology partnership forums have included renewable energy, bioinformatics, robotic technology for first responders and homeland security, biomedical technology, and nanotechnology.

A recent example of interagency partnerships is the LAUNCH initiative, which is a partnership between NASA, the U.S. Agency for International Development (USAID), and the State Department, as well as private entities. LAUNCH is a global initiative to identify and support the innovative work poised to contribute to a sustainable future and accelerate solutions to meet urgent challenges facing our society. This is achieved through a series of forums. The first was *LAUNCH: Water* in March 2010, and the next was *LAUNCH: Health* in October 2010.

NAC 2010-02-18 (TIC-05)
Encouraging Diversity of Thought

Recommendation:
The Council encourages NASA to engage in cross-fertilization of personnel between NASA Centers and between NASA and outside organizations through Intergovernmental Personnel Act (IPA) Agreements and rotational assignments as a way of encouraging innovation as the Agency Plans and implements its new technology programs and in general. Innovation results from exposure to new ideas, new people, new workplaces.

NASA Response:
NASA concurs with both the Council's contention that innovation results from exposure to new ideas, new people, and new workplaces and the Council's recognition that IPA and rotational assignments support such innovation. NASA will continue to encourage both mechanisms for cross-fertilization of personnel and ideas. Rotational assignments of varying lengths are key components of several of the Agency's formal development programs, including the new Mid-Level Leadership Program and the SES Candidate Development Program. In addition, Center-to-Center detail assignments are highly encouraged and frequently utilized by a large number of organizations. In some cases (including, but not limited to, the NASA Engineering and Safety Center and, currently, the Office of the Chief Technologist) detailees comprise significant percentages of the total organizational complement. Also, significant numbers of IPA scientists and other personnel travel between NASA and academia on a regular basis. Such employees fill key positions in the NASA hierarchy during their tenure with the Agency.

Tracking Number: SC-09-05
Study of Space Communications – Requirements, Capabilities, and Architecture

NASA Advisory Council Recommendation:
The Council recommends NASA contract for an independent study of space communications needs for science, exploration, and space operations, including:

- Assessment of needs
- Assessment of new and emerging communications technologies
- End-to-end view of the communications system
- Identification of future capabilities that may not be available commercially
- Identification of factors including cost that should define an optimal mix of optical communications, radio arrays, and other techniques
- Consideration of international and interagency plans

The report resulting from this study should include findings and recommendations that will assist NASA in planning a communications architecture that will enable the successful conduct of missions planned or conceivable through 2030 as well as the national objectives outlined above. This study should result in recommendations that will assist NASA in development of more detailed, quantifiable requirements.

Major Reasons for the Recommendation:
NASA's space communications infrastructure is aging, while the number of missions and data rates is increasing. NASA is already constrained by limits in total communications capability from some missions, including science and other vital NASA operational space missions. For the future, NASA is embarking on long-term planning for human and robotic exploration of the Moon and beyond as well as continued scientific exploration of the solar system and the universe. Both scientific data collection and safe mission operations will be highly dependent on more robust communications capability. NASA is already examining the architecture for improved space communications.

This planning would be usefully informed by an independent, external study of future space communications needs and capabilities. Any major upgrade to the nation's space communications capability must endure for several decades and incorporate new and evolving technologies as well as security and growth capabilities as a national asset. It is therefore vital that the study include the views of other U.S. Government, academic, and commercial potential customers and that these stakeholders should have a strong input to such a study.

NASA Response:
NASA established an independent Standing Review Board (SRB) and conducted a Program Implementation Review of the Space Communications and Navigation (SCaN) Program. The SRB reported on its results to the Agency Program Management Council on June 9, 2010.

An overview and status of the SCaN Program and the findings from the PIR are summarized below:

The mission of SCaN is to provide communications and navigation services, including systems engineering and planning, to flight missions and supply terrestrial communications services. SCaN is responsible for maintaining and evolving the system architecture to effectively and efficiently meet flight missions. SCaN's Architectural Design Document (ADD) is currently undergoing its second revision, with comments received and being processed. The SCaN Program Board of Directors addressed the final revision of the ADD in September 2010. The SCaN management approach is to modernize and upgrade aging infrastructure while integrating and building a scalable and adaptive architecture with state-of-the-art capabilities that will further science and exploration objectives to meet anticipated future NASA mission needs. The Integrated Network implementation strategy is to resolve obsolescence, aging, and stove-piping within the individual existing networks prior to undertaking integration efforts that will occur in two overlapping phases: 1) changes that can be made within existing projects while operating existing networks (e.g., support processes, standardized interfaces), and 2) changes that require new hardware/software and cannot be implemented within ongoing projects and activities.

SRB findings summary:

- SCaN leadership is strong, engaging stakeholders and users, and is focused on strategic communications.
- SCaN is effectively managed, with a strong Program Office and solid Field Center support.
- The technical approach to an integrated network of networks is sound.
- Program risks are being identified and managed with reasonable mitigation plans.
- Management challenges remain due to the lack of new funding infusion:
    - Space Network Operations funding beginning in FY 2013 (~$80M/yr).
    - Program funding reserves are critically low ($19-53M/yr).
    - Tracking and Data Relay Satellite (TDRS) M/N acquisition decision requires Agency level attention.
    - The 70-meter replacement, Optical Communication Network, the Flight Dynamics Facility and the Disruption Tolerant Network are significant funding threats.
- To meet funding demands, SCaN, a $400M program with less than $3M in reserves, defers maintenance, when possible, so as not to impact ongoing missions and

development projects. In general, SCaN development projects are adequately funded with reserves.

- The current Agency budget plan does not provide adequate funding for continued operation of the Space Network (SN) starting in FY 2013, an approximately $80M per year requirement, which has the potential for significant impacts to both NASA and external users of the SN. SCaN and SOMD are exploring options to renegotiate funding with external partners for the SN, which is also related to the TDRS M/N decision. [Note that the TDRS K/L Memorandum of Agreement (MOA) requires the partners to pay reimbursable rates until TDRS K or L Initial Operational Capability (IOC)]. The Space Network Expansion (SNE) MOA requires the partners to pay the full cost of terminal operations. Currently, the partners only pay the marginal cost of SNE-W since they pay TDRSS rates for use of all other TDRS spacecraft. NASA is negotiating with the partners an equitable apportionment of the SN terminals' operational costs. The expectation is that the partners will provide one third to one half of the operations cost for the SN operations for their two dedicated terminals. NASA expects to finalize this agreement in FY 2011. At that point, SCaN will know the level of NASA direct funding required to adequately operate and maintain the TDRS ground terminals. SCaN shall then submit a request for required funding as part of its FY 2013 budget submission. SOMD is also carrying this operations shortfall as a threat for FY 2013 and beyond.]

- SCaN lacks Optical Communications funding to continue testing and, ultimately, implementation by 2025. Key optical technologies are required by 2015 for the successful implementation of the optical communications link capability, including demonstration of efficient direct-to-Earth optical links utilizing photon-counting receivers. Currently, only the Lunar Atmosphere and Dust Environment Explorer laser communication technology demonstration is funded. The SRB recommends that Optical Communications be established as a project within the SCaN Program. SCaN is coordinating with the OCT, SMD, and ESMD regarding a shared interest in demonstrations and technology development and, while uncertain about FY 2011 budgets, all agree that Optical Communications is a high priority for NASA. [Note that Optical Communications has been recognized as a high priority and was addressed in the context of planning for the FY 2012 budget. The requirements and funding level are being coordinated among relevant organizations, as noted above].

- With a loss of external reimbursements, the imminent retirement of the Shuttle, and the cancellation of Constellation, there is a question about funding to support the Flight Dynamics Facility (FDF) operations costs, an Agency capability that supports all U.S. launches to Earth orbit. The SRB recommended that the Agency include the FDF as an integrated element of SCaN (for both budget and architecture purposes). Follow-on review of whether, and if so, how, to do this is being conducted under the auspices of the SCaN Board of Directors.

- Although the DTN is still in its infancy, without an implementation plan and full requirements, and funding is not yet estimated, DTN has been added to the SCaN architecture plan and is in the process of being integrated into their architecture roadmap and implementation planning. SCaN is reviewing what budget would be required to

develop supporting protocols in the DTN suite that are required to deploy an operational space internetwork.

The SRB recommended that SCaN proceed with operations as planned, and that the Agency should demonstrate an adequate funding profile for the Space Network Operations in FY 2013 and out, the 70-meter replacement effort, and should bolster SCaN Program annual reserves. Alternately, this should reduce SCaN's scope of work through a Program Commitment Agreement (PCA) and program plan update. [Note: Followups on the PIR recommendations are reviewed at the Agency Program Management Council by NASA's Associate Administrator].

NASA proposes to have an interactive dialogue with the NASA Advisory Council on this topic and offers to have the Chairman of the PIR brief the Council.